Filling in the Gaps: Holistic Support Emphasizing the Value of Making and Doing Survival for Non-traditional Technology Engineering and Design Teachers

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Author Note

Trey and I began this action research project as the result of our parallel journeys in teaching contemporary Technology, Engineering, and Design practices and principles in our respective classrooms. Our paths to practice began in the early 1990s. Steve was a traditionally prepared educator; Trey earned licensure through a Master's Degree in Technology Education. We are both long-standing makers and doers, but for various reasons, we've now come to a point in our careers, where we need to hone our high-tech skills in the "doing" of digital file preparation and 3D printing, as well as the "making" through CNC machining, and other materials processing technologies. The national crisis of teacher preparation has spurred us to look at our experiences and to seek effective ways to help other traditionally and non-traditionally prepared Technology, Engineering, and Design teachers. We are heavily invested in our Critical Action Research. There is both personal relevancy and an altruistic motivation to the work being presented.

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Abstract

Building upon the 2022 MVTTEC Conference Proceeding entitled Making and Doing Survival Skills for Non-traditional Technology, Engineering, and Design Teachers (Miller & Moore, 2022), presenters will demonstrate progress made in creating a holistic network of support for making and doing survival skills for new and non-traditional teachers. Utilizing a university approved Critical Participatory Action Research Methodology, presenters will share on-going work to develop an ad-hoc network of veteran and new teachers as well as content specific material resources (Altricher, et al., 2002). The goal of these efforts is to retain teachers through resources that instruct, enhance, and foster Technology, Engineering, and Design teaching practices. The presenters will provide, North Carolina based, numerical evidence of the current state of in-service beginning teacher induction program participants in addition to data about early career continuing license teachers. The research and teaching presentation will progress through resources that include Quick Start Guides encompassing low and high tech discipline-related skills; a residential NC-based Survival Skills Boot Camp; and specifics about the fledgling support network of Technology, Engineering, and Design Education professionals who volunteer their time to foster new and non-traditional teachers through their critical, initial licensure cycle.

Surviving the first years of teaching is crucial to keeping teachers in the classroom (DePaul, 2000). Beyond the initial years of establishing general, effective, pedagogical and instructional skills, Technology, Engineering, and Design Education teachers face compounding challenges. They are often alone within their school building. This “singleton” status and the requirement of managing some type of making and doing space create an acute pressure that exceeds the typical new teacher challenges.

Mentoring programs have been well-researched and established as a critical and effective component of teacher retention (Lozinak, 2016). In addition to mentoring, our work incorporates a variety of guides that support making and doing in the Technology Education classroom. This combination of mentoring and content specific knowledge has promise in helping to fill in gaps facing our new and non-traditional Technology, Engineering, and Design Education Teachers.

I. The Numbers from North Carolina

This research endeavor is targeting support for new or relatively new alternatively prepared in-service teachers. This section will provide North Carolina-specific numbers, pathways, and secondary challenges for teaching in general. Numerical data by teacher is not yet available, but data for 2022-23 course enrollments is available. This dataset provides insight to teaching numbers through local education agencies (LEA) offering the courses and the subsequent student enrollment.

In North Carolina, there are two routes to certification for those who have not completed a traditional teacher preparation program. A provisional, restricted license may be granted to a

teacher with a related degree, industry, or work experience. Those with a related degree but no related work experience are entered into the North Carolina Residency Program (Miller and Moore, 2022, p.3). Alternatively prepared teachers begin a residency program or a Master's in the Art of Teaching (MAT). The MAT is a master's degree program that also integrates a supervised teaching experience in addition to graduate coursework. The residency program participants enroll in a New Teacher Induction Program or the Pathway to Practice Program. These programs provide a teaching license upon successfully completing the master's degree or the certificate program. Beyond the general numbers of the new, in-service teachers and their new teacher program characteristics, there is a secondary issue related to attrition.

As with almost all teaching in the United States, the number of vacancies due to retirement and normal, as well as accelerated attrition, are high. The term accelerated attrition is being included within this research paper to accentuate the fact that there are a significant number of teachers who make the commitment to enter the profession through a traditional EPP or an alternative pathway, and not many years after entering, they exit, citing all manner of reasons for their premature departure.

Alternative routes to certification have been implemented to fill a long continuing increase in teacher vacancies. Technology Education has been far from exempt in seeing growing numbers of teacher vacancies. For the 2017-18 school year, North Carolina reported 1,621 unfilled teacher vacancies, with the need for Career and Technical Education teachers among the highest need positions and, in particular, grades 9-12 being the highest among all grade 9-12 content areas (Darling-Hammond et al., 2019, pp.15-16). The increasing number of teacher vacancies is exacerbated by a decrease in enrollment in TED Education Preparation Programs at both the undergraduate and graduate level. Darling-Hammonds's 2019 report found:

> Enrollments in traditional teacher education programs declined by more than 50% between 2008–09 and 2015–16, whereas enrollments in alternative, non-IHE-based preparation programs more than tripled between 2010 and 2015–16. There were no enrollments in such programs prior to 2010. Of 15,649 enrollees in teacher preparation in 2015–16, nearly half (7,216) were enrolled in alternative programs, most of them in programs not associated with IHEs … The largest numbers are in what the state calls its "lateral-entry program." (p.19)

Miller and Moore (2022) report that in North Carolina, the decrease in enrollments in teacher preparation programs and the consequent decrease in undergraduate and graduate candidates have elevated the demand to fill vacancies with candidates through non-traditional teacher preparation programs. In North Carolina, these new TED teachers are classified in one of two ways (Curran, 2022). A new teacher with a related degree, industry, or work experience is granted a provisional, restricted license. This is significant because the differences in the effectiveness and retention of teachers from these two pathways are considerable (Darling-Hammond et al., 2019). Additionally, these changes in the sources of teacher supply are

important because there are major differences in the effectiveness and retention of teachers from these different pathways. A study by Henry and colleagues (2014) found that in North Carolina, traditionally prepared teachers were significantly more effective than those prepared out-of-state and those by alternative pathways. These arguably less effective teachers are also most likely employed in high-poverty districts. These dynamics must be noted because of their potential for its effect on the sound basic education of North Carolina's most vulnerable students. Meanwhile, lateral-entry teachers other than the small proportion who are Teach for America (TFA) recruits, were significantly less effective than teachers who had been prepared before entry (Darling-Hammond et al., 2019). There are implications within these data points to build additional mechanisms within the alternative pathways, which will ensure greater efficacy within new teacher performance.

Beyond teaching quality, the teacher retention numbers reveal another dynamic to be discussed within this paper. Retention of these alternatively licensed inductees is lower than their traditionally prepared counterparts. In this case the older term of lateral entry is used in lieu of alternatively licensed. Lateral Entry inductees demonstrated a 3-year retention rate of 65% and a 5-year retention rate = 48%. The attrition rate for lateral-entry teachers was 15.5%, more than twice the rate for non-lateral-entry teachers (Darling-Hammond et. al, 2019 p.26). These differences in attrition rates mirror national trends, which show that teachers without prior preparation leave the profession at two to three times the rate of those who are comprehensively prepared (Ingersoll, Merrill, & May 2014).

II. Features of Alternative Certification/Licensure Programs

Alternative certification and licensure programs include a number of characteristics designed to ensure successful induction and completion of the newly hired in-service candidates. These program characteristics may include coursework, professional development, coaching, mentoring, field experience(s), and conference sessions. While not all programs include each component, they all include some of the components as mentioned earlier. Many significant data points emerge from *Educator Supply, Demand, and Quality in North Carolina: Current Status and Recommendations* (Darling Hammond, et. al., 2019). Numerical data related to the number of traditionally vs. alternatively prepared enrollments and their subsequent completion rate follow: as of 2015-16, there were 15,649 total teacher preparation enrollees. 8,433 were enrolled in traditional programs, 1,291 were enrolled in Alternative Institute of Higher Education (IHE) programs, and 5,925 enrollees were involved in Alternative, Non-IHE-Based Programs. 54% of the total enrollees were involved in traditional EPP programs, yet 76% of the completers came from the traditional programs. The lower completion rate within non-traditional programs is attributed to their extended completion timeframe and accelerated departure rate. They begin the alternative pathway programs (IHE or Non-IHE) and exit the profession before their sixth year in exceptionally high numbers.

The research indicates varying levels of efficacy with each of the components and programs. Compared to completers of traditional teacher preparation programs the retention rate of candidates from alternative programs is notably lower. Short of some extraordinary statewide measures to eliminate the demand for alternative licensure pathways, North Carolina is providing alternative solutions that have become a long-term default for Technology, Engineering, and Design as well as most other curricular areas. One principle component is mentoring. Mentoring provides the new teacher with a person who is purported to have similar experiences within the classroom. Ideally, the mentor has established their success in the classroom and is continuing to master professional skills. A mentor can be a current teacher, a specialist in new teacher support, or someone who may be distant but agrees to pick up the phone or answer an email when questions arise.

Another frequent component of alternative programs within North Carolina is their requirement for pedagogical skill development. Depending upon the program, it may take the form of coursework, instructional modules, or of intensive weekend training sessions. In a high percentage of the programs, pedagogical skill development is completed in conjunction with active teaching responsibilities. To counterbalance the student teaching component of a traditional teacher preparation program, there is some type of supervised teaching experience. In the case of the alternative pathways, the supervision takes place through a combination of extension, mentoring, and administrative observation.

Finally, provisions were made in North Carolina to apply for and operate “Grow Your Own” alternative teaching licensure. These programs are often facilitated between a local community college and an LEA. Teacher assistants and other eligible candidates are inducted into pre-service teaching. The unique nature of these “Grow Your Own” programs is the fact that many of the pre-service candidates have already opted into education but are doing so in a para-professional capacity. These programs are a boon to many small, rural communities because they elevate hometown persons who have been functioning in a working poor capacity. Their pay in a para-professional category is frequently half of what a classroom teacher earns.

These alternative pathways to licensure began as an urgent need to fill gaps in vacancies. Alternative pathways have now become the primary method of in-service teacher induction. Wrapping these new teachers with multiple layers of support is essential to build their capacity, resilience, and long-term dedication to the profession. It is important to note, “Keeping new teachers in teaching is not the same as helping them become good teachers. To accomplish the latter, we must treat the first years of teaching as a phase in learning to teach and surround new teachers with a professional culture that supports teacher learning.”(Feiman-Nemser, 2003) This can be accomplished through a program of mentoring and content-specific in-service training. In this manner, the new, non-traditionally prepared teacher may better find the support needed to become more than just a good teacher.

III. Mentoring

Mentoring is/has been the backbone of support for new teachers, traditionally and non-traditionally prepared. The positive relationships formed through mentoring programs can provide a much-needed feeling of collegiality (Lozinak, 2016). Even participants in a study conducted by Hung and Smith (2012) examining problems faced by MAT students identified a desire to be assigned a mentor while in the program. However, "We cannot assume that grade-level teams or other school structures automatically provide a forum for addressing new teachers' learning needs." (Feiman-Nemser, 2003) This is echoed by Lozinak (2016) who notes that effective induction programs go beyond mentoring and offer "multiple support personnel, study groups, and strong administrative support." This need for support beyond mentoring was found across the literature we reviewed.

IV. Content-Specific In-Service Training

The need for content-specific in-service training has been identified for non-traditionally or alternatively certified teachers. Finger and Houguet (2007) found that one challenge faced by participants in their study of implementing the technology education curriculum in Queensland, Australia, was their professional understanding and knowledge of technology education concepts and ideologies. Often at odds was the participants' understanding and perception of technology and the concepts presented in the curriculum. This challenge affected their confidence in teaching technology education, but as their understanding and knowledge grew, their confidence increased (Finger & Houguet, 2007). Hoepfl (2001) also found that while alternatively certified technology education teachers may have been hired based on their content area knowledge, they still felt inadequately prepared and that there was a desire for more training on technology education philosophy. Additionally, in a study by Hung and Smith (2012), one participant reported they would have felt much less stress with more content knowledge preparation.

Haynie (2008) advocates for more content-specific instruction in laboratory-based "hands-on" making experiences in our Technology Education teacher preparation programs. Through this specific, safety-based instruction and experiences, new teachers will more successfully and safely navigate our profession's foundational making and doing competencies. Additionally, making and doing is a major factor that influences students to enter technology education teacher preparation programs (Love & Love, 2022). We need to reinforce this drive to make and do, in all its facets, with our traditionally prepared pre-service education students and especially with our non-traditionally, alternatively certified teachers not only because it is what students enjoy doing but also because it is critical to the survival of the profession.

V. Making and Doing Survival Status Update

The alternative certification programs and the induction programs that offer multiple pathways to becoming a licensed teacher merely offer a short-term solution for supporting new

teacher survival in their first years (Feiman-Nemser, 2003). Our goal with this Making and Doing Survival Skills research project is not only to help these new, non-traditionally prepared teachers survive their first years in the classroom but to move from being a proxy teacher to becoming a full-fledged Technology, Engineering, and Design Education professional. As we noted earlier from Finger and Houguet (2007), there is a correlation between a teacher's knowledge and understanding of the content and their confidence in their ability to teach that content.

The Technology Education discipline has unique factors not present in other content areas, and chiefly, there is a level of expectation that Technology Education teachers will be providing project-based learning activities, activities that promote making and doing. This expectation is evidenced in North Carolina, where the final exam for students in the high school Technology Education programs is now a Performance Based Measure (PBM). The content-specific expectations for the TED teacher are extensive. Not only does the Technology Education teacher need to plan lessons that support making and doing, but they also have to operate and maintain a space for making and doing. Their responsibilities transcend classroom curricula. These teachers provide instruction in safety and content and must maintain instructional facilities, order equipment, and expendable instructional supplies. While not true of all environments, these special instructional characteristics are intertwined with the Technology Education teacher managing some type of makerspace, whether carved out of a traditional classroom setting or in a more traditional industrial arts shop space.

A. Participatory Critical Action Research

Our Making and Doing Survival Skills initiative seeks to address the need for mentoring and collegial relationships within the Technology Education discipline as well as provide support through content-specific literature and activities that promote the core making and doing philosophy of Technology, Engineering, and Design Education.

B. Fledgling Network of New and Veteran Teachers

There are many layers of support needed for beginning teachers. Mentoring has been identified as one of those needed layers of support. It is even more helpful when the mentor and mentee teach the same content area. The literature has also shown that beginning teachers need more content area support. As illustrated elsewhere in this paper, the demands for beginning Technology, Engineering, and Design teachers include additional responsibilities. A network of persons who have the appropriate discipline-specific skills and experiences AND who are willing to help on a moment's notice goes a long way toward keeping a teacher on a forward and positive trajectory. Suppose the new teacher can resolve content technical issues on the fly, so to

speak. In that case, they can focus their energy on areas of most gain and significance, such as lesson development and the ever-important classroom management.

C. The Quick Start Guides

Traditionally and non-traditionally prepared teachers alike, cite the reading of professional journals and other literature related to technology education as one of the most common forms of professional development. (Wash et al., 2000) (Bartholomew et al., 2022). The sharing of instructional materials has also been reported as another means of receiving professional development (Hung & Smith, 2012) (Bartholomew et al., 2022). To this end we have completed a first edition of nine quick start guides. Our Quick Start Guides have been shared at the International Technology and Engineering Education Association's 2023 Annual Conference and the North Carolina Department of Public Instruction's Career and Technical Education Summer Conference.

These Quick-Start Guides cover essential making and doing competencies such as low-tech and high-tech visualization, low-tech and high-tech prototyping, and fabrication along with a draft of prototyping with microcontrollers. While the wealth of information for each topic listed within the Quick-Start guides is vast, it is too vast! A new teacher's learning curve within TED is almost as exhaustive. The Quick Start Guides are a foundational and condensed set of easily editable documents that provide a concise, discipline-specific jumpstart for teachers who are being pulled in far too many directions. A portion of the critical participatory action research project is to continue to improve these Quick Start Guides by crowdsourcing the expertise of others who wish to give back or to deepen other teachers' understanding from a segment of their expertise.

D. Survival Skills Boot Camp

Also ranking high with the reading of professional literature and sharing of curricular resources as a source of professional development is participation in in-service workshops (Wash et al., 2000) (Bartholomew et al., 2022). Plans are underway for what we are calling a Survival Skills Boot Camp. A three-day-long jumpstart into making and doing for non-traditionally licensed TED teachers. This boot camp will closely follow the Quick Start Survival guides, taking teachers through the spectrums of visualization and prototyping. Beyond the content from Quick Start Guides, participants will engage in fabrication space safety and STELs in conjunction with student projects.

Most importantly, the Boot Camp will be provided in an environment which will allow the teachers to complete projects in a "high-tech" digital fabrication space and a materials and processes production space. The intent is to safely and intensively offer making and doing experiences for participants who may have little to no background in the hands-on components of Technology, Engineering, and Design Education.

VI. Conclusions

Obtaining granular data for North Carolina Licensure Area 820 - Technology Engineering and Design Education, has been frustratingly elusive. We continue to escalate our requests through appropriate agencies, and a number of barriers have been resolved. There is promise that we've moved closer to "Purple Data," which is identified as the most sensitive data available from which to draw research conclusions and to determine overall descriptive statistics. In the meantime, we have obtained what data is available within North Carolina to provide as full a picture as currently possible. While most of our data points and findings on the needs of non-traditionally trained teachers are being drawn from general North Carolina alternative licensure programs, general comparisons may be extended to our discipline based on the preponderance of the data within North Carolina, the United States, and even outside the United States.

The trends indicating the state of the Technology, Engineering, and Design Education profession are dire. Yes, similar trends have been discussed and researched since the turn of the 21st Century, but the overall challenges within the state of public education and public charters serve to heighten the teacher recruitment and retention challenges through traditional and alternative means. Significant research is needed to identify efficacious solutions to the difficulties revealed by the numbers and also through deficiencies told to us by traditionally and non-traditionally trained Technology Education teachers.,

Additionally, questions abound about the deficiencies in content-specific training, for TED teachers as well as providing the pedagogical support needed for the new teacher. Is there a foundation to help build and develop professional, collegial relationships among other Technology Education teachers? Is there support to promote making and doing and to instill the philosophy of Technology, Engineering, and Design Education?

Any new teacher is walking into a world of many and varied pitfalls when they begin the work of teaching. It begins with the walk onto campus. Is it an urban, suburban, or rural school? What is the student population like beyond the demographics? What is the professional culture of the school? From there is the walk into the classroom. The new teacher now faces the students. What attitudes, habits, and behaviors were instilled by the previous instructor? What are student expectations about the teacher and the course? This is on top of all the unique aspects of being a Technology, Engineering, and Design teacher with all of the aforementioned responsibilities for safety, facilities, machines, tools, supplies, and an exponential learning curve.

To say it is overwhelming is to grossly understate the situation faced by the new Technology, Engineering, and Design teacher. This Participatory Critical Action Research is one small but noble attempt to change the alarming trajectory of one, two, or many new teachers who are not even aware of the layers of challenge facing them. If we do not continue to develop Survival Skills for Making and Doing, then there is even less of a chance that a new teacher will survive even the first nine weeks of a school year. There will have been No Help Along the Way.

Recent experiences and research affirms that making and doing keeps students in school and the TED program. Making and doing fosters interest in students becoming Technology Education teachers. Making and doing is the soul of the profession, and we must ensure that our new teachers carry on this tradition.

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Appendix A

North Carolina Technology Engineering Design Course Enrollment

Course Number	Course Name	2022-2023 Enrollment
TE11	Technology Engineering and Design	6,209
TP11	PLTW Introduction to Engineering Design	4,162
TP12	PLTW Principles of Engineering	1,743
IV22	Drafting II - Engineering	903
TL04	Engineering Technology I	880
TE12	Technological Design	783
TL18	Robotics I	753
TP23	PLTW Civil Engineering and Architecture	677
TL08	Engineering and Technical Foundations I A	600
TE13	Engineering Design	482
TP31	PLTW Engineering Design and Development	389
TP22	PLTW Computer Integrated Manufacturing	373
TL05	Engineering Technology II	348
TP21	PLTW Digital Electronics	323
TL19	Robotics II	312
WB57	CTE Advanced Studies STEM	282
TP25	PLTW Aerospace Engineering	281
TL09	Engineering and Technical Foundations I B	247
WB59	CTE Internship STEM	180
IV23	Drafting III - Engineering	169
IK11	Introduction to Engineering	165
TL06	Engineering Technology III	146

TP13	PLTW Engineering Essentials	114
TL03	Applications of Engineering Technology	88
TP27	PLTW Environmental Sustainability	73

Appendix B

North Carolina CTE Technology Engineering and Design Courses by County